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Impact of antenatal common mental disorders upon perinatal outcomes in Ethiopia: the P-MaMiE population-based cohort study

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Summary

OBJECTIVES To examine the impact of antenatal psychosocial stressors, including maternal common mental disorders (CMD), upon low birth weight, stillbirth and neonatal mortality, and other perinatal outcomes in rural Ethiopia.

METHODS A population-based sample of 1065 pregnant women was assessed for symptoms of antenatal CMD (Self-Reporting Questionnaire-20: SRQ-20), stressful life events during pregnancy (List of Threatening Experiences: LTE) and worry about the forthcoming delivery. In a sub-sample of 654 women from six rural sub-districts, neonatal birth weight was measured on 521 (79.7%) singleton babies within 48 h of delivery. Information about other perinatal outcomes was obtained shortly after birth from the mother's verbal report and via the Demographic Surveillance System.

RESULTS After adjusting for potential confounders, none of the psychosocial stressors were associated with lower mean birth weight, stillbirth or neonatal mortality. Increasing levels of antenatal CMD symptoms were associated both with prolonged labour (>24 h) (SRQ 1–5: RR 1.4; 95% CI 1.0–1.9, SRQ ≥ 6: RR 1.6; 95% CI 1.0–2.6) and delaying initiation of breast-feeding more than eight hours (SRQ 1–5: RR 1.4; 95% CI 0.8 to 2.4, SRQ ≥ 6: RR 2.8; 95% CI 1.3–6.1). Worry about delivery was also associated with labour longer than 24 h (RR 1.5; 95% CI 1.0–2.1).

CONCLUSIONS This study provides preliminary evidence of important public health consequences of poor maternal mental health in low-income countries but does not replicate the strong association with low birth weight found in South Asia.

keywords pregnancy, birth weight, mental disorder, sub-Saharan Africa, breast feeding, obstetric labour complications

Introduction

There are conflicting reports from high-income countries about the association between psychosocial stressors in pregnancy and perinatal outcomes (Paarlberg *et al.* 1995; Bonari *et al.* 2004). Most often replicated have been associations between stressful life events (Paarlberg *et al.* 1995) or pregnancy-specific anxiety (Rini *et al.* 1999) and preterm birth. Other intra-partum complications, including prolonged labour and instrumental delivery, have also been found more commonly in women who are anxious or exposed to significant stress in pregnancy (Paarlberg *et al.* 1995; Chung *et al.* 2001). Antenatal common mental disorders (CMD), characterised by depressive, anxiety, panic and somatic symptoms, have been inconsistently associated with low birth weight in high-income settings (Andersson *et al.* 2004), with positive findings tending to come from studies of disadvantaged populations (Bonari *et al.* 2004) or among women who were underweight prior to conception (Cliver *et al.* 1992; Hobel & Culhane 2003).

In South Asia, two recent cohort studies found associations between antenatal CMD and low birth weight: In India, an odds ratio of 1.44 (95% CI 1.00–2.07) after adjusting for age, parental educational level, income, antenatal medical problems and experience of antenatal violence (Patel & Prince 2006), and, in Pakistan, an odds ratio of 2.2 (1.2–4.0) after adjusting for poverty, parity, maternal nutrition, antenatal attendance and social support (Rahman *et al.* 2007). In Zambia, antenatal CMD was associated with birth length but not birth weight or delivery complications, although adjusted analyses were not presented (Collin *et al.* 2006). Antenatal CMD may be associated with particularly poor perinatal outcomes in settings where conditions of poverty, maternal undernutrition and ill-health, and limited access to health facilities prevail.

Conceptual models linking exposure to antenatal psychosocial stress with poor perinatal outcomes hypothesise both direct and indirect effects. There is some evidence supporting direct effects of psychoneuroendocrine processes upon obstetric complications and foetal outcomes (Paarlberg *et al.* 1995; Wadhwa *et al.* 2001; Halbreich 2005; Field *et al.* 2006). Impaired maternal mental health has also been associated with unhealthy maternal antenatal behaviours, including reduced attendance for antenatal care, increased substance use, and lower weight gain in pregnancy (Zuckerman *et al.* 1989; Dayan *et al.* 2002), which, in turn, increase the likelihood of preterm delivery, low birth weight and neonatal mortality (Bonari *et al.* 2004).

In this paper we present findings from a population-based cohort, the Perinatal Maternal Mental Disorder in Ethiopia (P-MaMiE) study. This study prospectively evaluated the impact of antenatal CMD upon birth weight, delivery outcomes and initiation of breast-feeding, and was the first study from any low-income country to investigate the impact of antenatal CMD upon foetal and neonatal survival.

Methods

This was a population-based cohort study of women recruited in pregnancy and followed up, together with their newborn baby, until one month post-partum.

Setting and participants

The study took place in the Demographic Surveillance Site (DSS) at the Butajira Rural Health Programme (BRHP), Ethiopia (Berhane *et al.* 1999). The DSS population currently numbers 49 943, with 13 268 women of reproductive age, is predominantly rural and is located around 130 km south of the capital city, Addis Ababa. Poor perinatal outcomes are commonplace in Ethiopia, with stillbirths estimated to occur in 20/1000 total births (WHO 2006), low birth weight in 15% of deliveries (Wardlaw *et al.* 2004) and neonatal mortality in 39/1000 live births (Central Statistical Authority [Ethiopia] and ORC Macro 2006).

Eligible women were between the ages of 15 and 49 years, able to speak in Amharic (the national language of Ethiopia), living in the DSS and in the third trimester of pregnancy during the study recruitment period (July 2005 to February 2006). The women were identified by the BRHP enumerators in the course of their 3-monthly surveillance interviews and, after giving informed consent, were interviewed by the project data collectors. These data collectors were local women with completed high school education (tenth grade) who worked exclusively on the P-MaMiE project. The project data collectors administered questionnaires covering all the antenatal variables and carried out the maternal anthropometric measurements.

Measures

Mental health

Antenatal CMD was measured at recruitment using the Self-Reporting Questionnaire (SRQ-20) (Beusenberg *et al.* 1994). This 20-item scale asks about depressive, anxiety, panic and somatic symptoms present in the preceding month and generates a continuously distributed scale score, indicating level of overall psychological morbidity. The SRQ has been used in previous Ethiopian community-based studies (Alem *et al.* 1999), but was extensively pre-validated for use in a mixed sample of pregnant and postnatal women in the Butajira population, with area under the receiver operating curve estimates of 0.82 (95% CI 0.68–0.96) and 0.70 (95% CI 0.57–0.83) (Hanlon *et al.* 2007). The AUROC estimate was not significantly different when considering pregnant women alone. SRQ scores were categorised into ‘no symptoms’ (SRQ = 0), ‘low CMD symptoms’ (SRQ 1 to 5) and ‘high CMD symptoms’ (SRQ 6 and above) to explore CMD as a dimensional exposure.

Other psychosocial exposures

The original list of threatening experiences (LTE) (Brugha *et al.* 1985) provides a measure of 12 life event categories associated with long-term threat. The LTE was translated into Amharic, adapted for local conditions and the time-frame restricted to the current pregnancy. In addition, women were asked whether they were worried about the forthcoming delivery.

Potential confounders

Socio-economic status was indicated indirectly by asking about (i) hunger in the preceding month due to lack of money or food, (ii) subjective report of wealth relative to others and (iii) indebtedness. Educational level was reported and functional literacy directly evaluated through the woman's ability to read a portion of the consent form.

Self-report data was obtained on marital status, ethnicity, obstetric history (parity, previous stillbirth or neonatal death), substance use (alcohol, khat and tobacco), antenatal care, receipt of tetanus toxoid immunisation, physical assault during pregnancy, unwanted pregnancy, subjective physical ill-health and episodes of fever and malaria during pregnancy. Maternal weight, height and mid-upper arm circumference (MUAC) were measured using standard anthropometric techniques (WHO Expert Committee 1995).

Outcome measures

In six of the rural sub-districts community health agents (CHAs) were trained to measure birth weight using SECA 725 scales measuring to an accuracy of 10 g. The CHAs live and work in the sub-district and are well-known to the women. After giving birth, participating women were requested to inform the CHA to enable the neonate to be weighed within 24 to 48 h of birth. Birth weights were not measured in the remaining four sub-districts as no suitable health worker was available.

A questionnaire was administered to women at the time of measuring birth weight or in the few days after birth (median 2 days; 73% within 1 week, 82% within 2 weeks) in order to obtain information on stillbirths, prolonged labour (lasting longer than 24 h) and time to initiation of breast-feeding (within an hour of birth, between 1 and 8 h, between 8 and 24 h, and greater than 24 h). The latter was only assessed for singleton babies surviving the first 24 h after birth. In the sub-districts where birth weight was not measured, the questionnaire was administered by the project data collectors, having been informed by the traditional birth attendant or BRHP enumerators that the woman had given birth. Neonatal mortality (within 28 days of birth) was assessed through the DSS enumeration system. As women in this setting were unable to report their gestation at delivery with any accuracy we were unable to measure preterm delivery.

Data management

Data were checked in the field by supervisors and double-entered on the day of collection using Epidata (Lauritsen & Bruus 2003) . Women were re-interviewed within one week if data was missing. Ongoing quality checks were performed by the supervisors and first authors (CH and GM).

Statistical analyses

Stata version 8.1 (Stata Corporation 2003) software was used for data analysis. Percentages and mean values, with their corresponding 95% confidence intervals (CIs), were used to summarise categorical and continuous variables respectively. Chi-squared analyses were conducted to look for significant differences in categorical characteristics between women whose babies were not weighed compared to those who were weighed. Pearson correlation coefficients were estimated for maternal anthropometric measures.

Univariate analyses

The association between the psychosocial exposures and potential confounders was evaluated using analysis of variance for continuous variables (*F*-tests and *P* values presented) and incidence risk ratios with 95% confidence intervals for categorical variables (only presented for the primary exposure of SRQ score categories). A test for linear trend across SRQ categories was conducted; Wald χ^2 statistics and *P* values are presented. Incidence risk ratio was chosen instead of odds ratio as the appropriate measure of effect as risk ratios are less liable to misinterpretation (Katz 2006). Risk ratios were estimated using a Poisson working model and sandwich estimators of the standard errors (Lumley *et al.* 2006). Linear regression was used to evaluate the associations between potential confounders for the outcome of birth weight. SRQ was considered primarily as an ordered categorical exposure, with the cut-off for 'high symptoms' (SRQ ≥6) as indicated by the validation study (Hanlon *et al.* 2007). We also looked for linear effects of SRQ score. For the outcome of birth weight, linear effect of SRQ, age and maternal anthropometric measures was assessed visually using scatter plots. Likelihood ratio tests were then used to compare models with and without assumption of linear effect for each exposure. Parity and life events were treated as categorical variables.

Multivariable analyses

Potential confounders were identified *a priori* on theoretical grounds and divided into those which were common to all perinatal outcomes (shared confounders) and those which were specific to individual outcomes. All potential confounders were included in the final multivariable models. All analyses additionally included the month of gestation of the mother when she was recruited (7, 8 or 9 months) in order to adjust for time-varying variables in pregnancy e.g. maternal weight. The adjusted effect of gestation at recruitment was not presented as this was not considered to be a potential confounder. Multiple linear regression was used for the continuous outcome of birth weight. For the categorical perinatal outcomes, the Poisson working model with robust standard errors was used as described above (Lumley *et al.* 2006).

Ethical considerations

Ethical approval was obtained from the National Ethical Review Committee for Ethiopia and the Research Ethics Committee of King's College London in the UK. Written, informed consent was obtained in keeping with requirements of the Ethiopia ethics committee. As the majority of women were non-literate, the form was read to them and they were required to give a finger-print to signify willingness to participate. All women were reimbursed for health care costs. Those women who were suffering from severe mental disturbance were referred for assessment at the local psychiatric unit in Butajira town, staffed by two psychiatric nurses. The decision to refer was made by the project co-ordinators (CH and GM) based on a review of all women who were expressing suicidal ideation or who seemed to be exhibiting signs of major mental illness.

Results

A flow chart of recruited women and the main outcomes is presented in Figure 1. Non-recruited women did not differ significantly from participating women in terms of age, religion, ethnicity, level of literacy, or location of residence.

The majority of women (77.6%) were Muslim, with the next largest religious group being Orthodox Christian (15.1%). The largest ethnic group was Meskan (45.5%), followed by Silti (24.1%) and Mareko (13.8%).

Distributions of the potential confounding variables are shown in Tables 1 and 2, together with their associations with increasing categories of antenatal CMD symptoms. High symptom levels (SRQ scores ≥6) were present in 128 (12.0%), low symptoms (SRQ scores 1–5) were present in 634 (59.5%) and no symptoms (SRQ = 0) in 303 (28.5%) of women. The distribution of SRQ scores was positively skewed (Figure 2), with a median of 2 (Inter-quartile range 4).

Significant associations were observed between increasing categories of antenatal CMD symptom category and increasing age, multiparity, hunger, being indebted, a history of stillbirth, worry about the forthcoming delivery, unwanted pregnancy, experience of threatening life events and violence during pregnancy. Self-reported indicators of poorer health were all strongly associated with increasing antenatal CMD symptoms, but there was no association with maternal anthropometric measures.

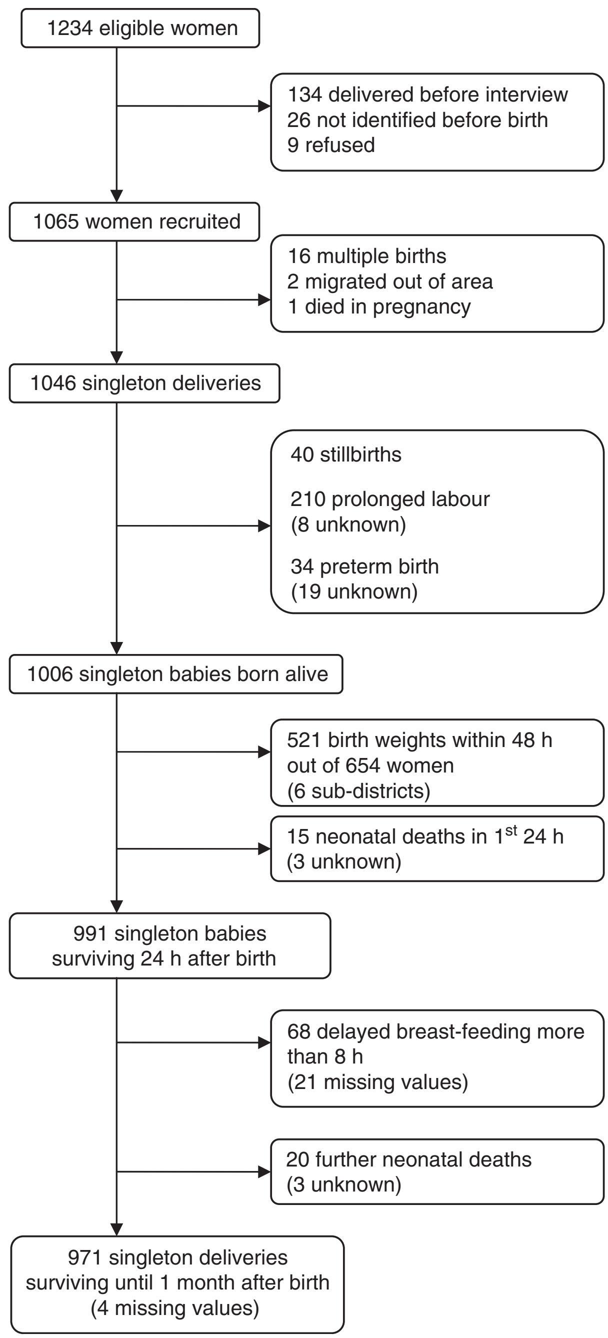

Figure 1 Flow chart of recruited pregnant women and perinatal outcomes.

Table 1 Continuously distributed characteristics of women with singleton deliveries (n = 1046) and analysis of variance across increasing levels of Self-Reporting Questionnaire (SRQ-20) score

	(n = 1046) Mean (SD)	SRQ score No symptoms mean (SD)	Low symptoms mean (SD)	High symptoms mean (SD)	F statistic (df between; within) P-value
Potential Confounders (shared)					
Age (years)	26.8 (6.4)	25.6 (6.3)	27.2 (6.2)	28.1 (7.0)	F (2;1043) 9.05 P < 0.0001
Maternal weight (kg)	54.3 (6.1)	54.2 (5.9)	54.3 (6.1)	54.5 (7.0)	F (2;1042) 0.09 P = 0.92
Body mass index (kg/m^2)	21.7 (2.3)	21.7 (2.1)	21.7 (2.3)	21.6 (2.6)	F (2;1018) 0.12 P = 0.9
Mid-upper arm circumference (cm)	24.7 (2.2)	24.8 (2.2)	24.7 (2.1)	24.9 (2.4)	F (2;1042) 0.80 P = 0.45

df, degrees of freedom.

Table 2 Categorical characteristics of women with singleton deliveries (n = 1046), and associated risk ratio (RR) for increasing levels of SRQ score, with robust standard errors

Sample characteristics	n (%)	RR (95% CI) for SRQ score compared to zero-scorers: Low (1–5)	High (6 & over)	P-value (χ^2 test-for-trend)
Psychosocial exposures				
Worry about delivery	820 (78.4)	1.1 (1.0–1.2)	1.2 (1.1–1.3)	0.0002
1 or more life event	425 (40.6)	2.2 (1.7–2.8)	3.8 (2.9–4.8)	<0.0001
Potential confounders (shared)				
Functionally non-literate	885 (84.6)	1.0 (1.0–1.1)	1.1 (1.0–1.2)	0.28
No maternal formal education	832 (79.5)	1.0 (0.9–1.0)	0.9 (0.8–1.0)	0.14
No paternal education (n = 1039)	382 (36.8)	1.0 (0.9–1.2)	1.0 (0.8–1.4)	0.86
Indebtedness	82 (7.8)	4.7 (1.9–11.7)	13.2 (5.2–33.5)	<0.0001
Lower relative wealth (n = 1044)	597 (57.2)	1.0 (0.9–1.1)	1.0 (0.9–1.2)	0.97
Hungry in last month	162 (15.5)	1.5 (1.0–2.3)	3.9 (2.5–5.9)	<0.0001
Nulliparous	160 (15.3)	0.7 (0.5 to 1.0)	0.7 (0.4 to 1.1)	0.03
Poor/bad global health	40 (3.8)	1.6 (0.6–4.4)	8.5 (3.2–22.4)	<0.0001
≥1 episode of fever in pregnancy	139 (13.1)	2.6 (1.5–4.5)	8.3 (4.7–14.5)	<0.0001
≥1 malarial episode (n = 1039)	165 (15.9)	1.8 (1.2 to 2.6)	2.4 (1.5 to 3.8)	<0.0001
Uses alcohol weekly or more	52 (5.0)	1.2 (0.6–2.4)	1.8 (0.8–4.1)	0.21
Uses khat weekly or more	135 (12.9)	1.6 (1.0–2.3)	1.4 (0.8–2.4)	0.12
Potential confounders (outcome specific)				
Polygamous marriage	198 (18.9)	1.2 (0.9–1.6)	0.9 (0.5–1.4)	0.94
No access to latrine	383 (36.6)	0.9 (0.8–1.1)	0.9 (0.7–1.2)	0.47
Ethnicity (Mareko)	147 (13.8)	1.1 (0.8–1.5)	0.9 (0.5–1.6)	0.90
Past stillbirth	45 (4.3)	1.9 (0.8–4.3)	3.4 (1.3–8.7)	0.005
Past neonatal death	261 (25.0)	0.9 (0.7–1.2)	0.9 (0.6–1.3)	0.48
Pregnancy interval < 12 months	23 (2.2)	1.3 (0.5–3.7)	1.9 (0.5–6.9)	0.34
No antenatal care	478 (45.7)	0.9 (0.8–1.1)	0.9 (0.7–1.1)	0.13
No tetanus toxoid	537 (51.3)	0.9 (0.8–1.1)	1.0 (0.8–1.2)	0.52
Physically assaulted during pregnancy	24 (2.3)	2.1 (0.6–7.2)	6.3 (1.7–23.4)	0.005
Unwanted pregnancy (n = 1045)	482 (46.1)	1.3 (1.1–1.6)	1.6 (1.3–1.9)	<0.0001

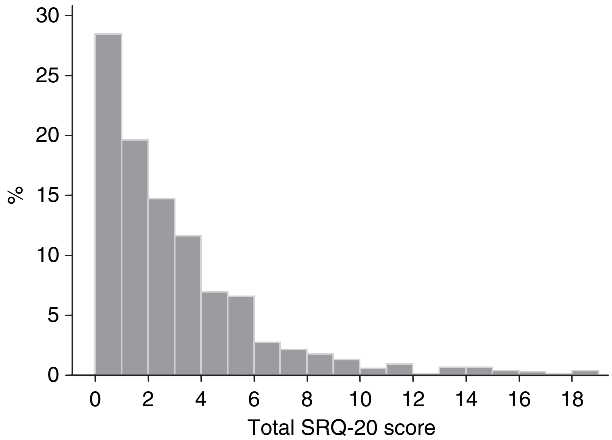

Figure 2 Frequency distribution of SRQ-20 total scores (n = 1065).

Birth weight

Birth weights were obtained within 48 h on 521 (79.7%) women living in the six sub-districts, 34.0% of which were measured within 24 h. The mean birth weight in the final sample was 3005.9 g (SD 382.7 g) and 7.3% were low birth weight (LBW; under 2500 g). Women from the six rural districts whose babies were not weighed within 48 h were more likely to be non-literate (97.0% *vs*. 90.0%; χ^2 = 6.58, P = 0.010) and nulliparous (22.6% *vs*. 12.7%; χ^2 = 8.27, P = 0.004). The association with nulliparity may have arisen because of the tradition that women tend to go back to their mother's home to deliver their first baby. The non-participating women were also less likely to have experienced an episode of malaria during pregnancy (12.0% *vs*. 19.9%; χ^2 = 4.37, P = 0.037). They did not differ with respect to age, socio-economic status, substance use or self-reported health status. They also did not differ with respect to any of the psychosocial exposures: 10.5% *vs*. 12.5% (unweighed *vs*. weighed) for high antenatal CMD symptoms (SRQ ≥ 6) [χ^2 (2) 0.71, P = 0.700], 17.3% *vs*. 14.4% for 2 or more life events [χ^2 (2) 1.78; P = 0.411] and 82.0% *vs*. 77.0% for worry about forthcoming delivery [χ^2 (1) 1.54; P = 0.215].

Mid-upper arm circumference (MUAC) was highly correlated with both maternal Body Mass Index (BMI) (r = 0.55; P < 0.0001) and weight (r = 0.63; P < 0.0001) but only maternal weight, rather than BMI, was significantly associated with birth weight; regression coefficients 7.8 (95%CI 2.3 to 13.3) and 11.8 (−2.5 to 26.1) respectively. Maternal weight rather than BMI was included in the adjusted model. Maternal literacy and formal education were also strongly associated (χ^2 = 227.4, P < 0.001), with literacy entered into the adjusted model.

In the fully adjusted model (Table 3), lower mean birth weight was not associated with exposure to increasing levels of antenatal CMD symptoms (categorical or as a linear scale), experience of stressful life events or worry in pregnancy. Likewise there was no significant association between any psychosocial exposure and the categorical outcome of low birth weight (Table 4). As expected, mean birth weight was significantly associated with the mother being of lower parity, non-literate and lower weight in pregnancy, as well as with lower levels of paternal education. However, women reporting hunger in the third trimester of pregnancy due to lack of money had significantly heavier babies (P = 0.006).

Secondary perinatal outcomes

In the multivariable model, none of the psychosocial exposures were associated with either stillbirth or neonatal death.

Labour lasting more than 24 h was independently associated with increasing categories of antenatal CMD symptoms (SRQ 1–5: RR 1.4; 1.0 to 1.9 and SRQ ≥6: RR 1.6; 1.0 to 2.6) and worry about the forthcoming delivery (RR 1.5; 1.0 to 2.1). Analyses did not support a linear effect of SRQ score.

Almost all women with singleton births surviving the first day of life (99.6%) commenced breastfeeding within 24 h of birth; 31.9% within the first hour, 61.1% between one and eight hours and 5.6% between eight and 24 h. In the multivariable model, delaying breastfeeding by more than eight hours was independently associated with increasing categories of antenatal CMD symptoms (SRQ 1–5: RR 1.4; 0.8 to 2.4 and SRQ ≥6: RR 2.8; 1.3 to 6.1). As for the outcome of prolonged labour, the data did not support a linear effect of SRQ score.

Discussion

Our cohort study did not replicate findings from South Asia of an association between maternal antenatal CMD and lower birth weight in a model adjusting for confounders, and no association with stillbirth or neonatal death was found. Poorer maternal mental health in pregnancy was, however, associated with reported prolonged labour and delayed initiation of breast-feeding. Strengths of our study include the population-based sample and the prospective design with minimal loss-to-follow-up. We obtained high coverage of birth weights in a rural setting where the vast majority of women deliver at home unattended by health workers.

Table 3 Adjusted linear regression model for difference in mean birth weight (n = 515)

		Mean weight difference in g (95%CI)	
Characteristic	n (%) or Mean (SD)	Crude	Adjusted
(i) Final model adjusting for potential confounders*			
Increasing age (years)	27.1 (6.3)	4.7 (−0.6 to 9.9)	−4.0 (−12.0 to 4.0)
Maternal non-literacy	464 (90.1)	−161.0 (−270.5 to −51.5)	−128.1 (−239.1 to −17.0)
No paternal education	211 (41.0)	−76.3 (−143.1 to −9.6)	−82.3 (−150.3 to −14.4)
Indebted	42 (8.2)	−24.1 (−144.5 to 96.4)	−117.2 (−243.9 to 9.5)
Self-reported lower wealth	283 (55.0)	−40.6 (−106.8 to 25.5)	−36.9 (−106.7 to 27.0)
Hunger in preceding month	94 (18.3)	145.8 (61.4 to 230.2)	163.1 (73.0 to 253.2)
Female baby	262 (50.9)	−55.6 (−121.3 to 10.2)	−47.6 (−112.3 to 17.1)
Parity			
Nulliparous	64 (12.4)	−188.4 (−297.2 to −79.6)	−260.9 (−420.4 to −101.4)
1–4 previous live births	284 (55.2)	−77.7 (−149.9 to −5.6)	−103.2 (−200.4 to −6.0)
≥5 live births	167 (32.4)	Reference	Reference
Maternal weight (Kg)	54.0 (5.9)	7.0 (1.5 to 12.6)	7.9 (2.3 to 13.5)
Alcohol at least weekly	17 (3.3)	102.9 (−81.4 to 287.3)	126.5 (−56.3 to 309.3)
Khat at least weekly	79 (15.3)	−39.8 (−131.3 to 51.6)	−36.4 (−128.1 to 55.3)
Poor/bad global health	20 (3.9)	12.9 (−157.8 to 183.5)	20.6 (−148.6 to 189.7)
Fever in pregnancy	70 (13.6)	−30.6 (−126.7 to 65.6)	−53.2 (−154.4 to 48.1)
Malaria episodes			
0	412 (80.0)	Reference	Reference
1	63 (12.2)	5.5 (−95.8 to 106.8)	18.5 (−83.0 to 120.1)
2	40 (7.8)	−7.4 (−131.5 to 116.6)	11.5 (−115.5 to 138.6)
Physically assaulted	14 (2.7)	−39.1 (−241.9 to 163.6)	−67.0 (−269.7 to 135.7)
No antenatal care	258 (50.1)	−3.5 (−69.5 to 62.4)	−5.0 (−71.5 to 61.5)
(ii) Psychosocial exposures individually adjusted for final model (i)*			
SRQ score			
Zero	152 (29.5)	Reference	Reference
1 to 5	299 (58.1)	0.4 (−74.2 to 75.0)	10.0 (−64.2 to 84.1)
6 or more	64 (12.4)	−17.8 (−129.4 to 93.8)	−18.3 (−141.8 to 105.2)
Stressful life events			
None	312 (60.6)	Reference	Reference
1	130 (25.2)	44.5 (−33.1 to 122.1)	45.9 (−31.5 to 123.3)
2 or more	73 (14.2)	135.1 (38.4 to 231.7)	109.0 (6.7 to 211.3)
Worried about delivery	395 (76.7)	20.8 (−57.1 to 98.8)	36.4 (−40.5 to 113.4)

*Also adjusted for mother's gestation at recruitment (months).

Ours is the first study of antenatal CMD and other possible psychosocial antecedents of lower birth weight in sub-Saharan Africa. Our negative findings conflict with the strong, prospective associations recently reported from Pakistan (Rahman *et al.* 2004) and India (Patel & Prince 2006). There are other discrepancies between South Asia and sub-Saharan Africa in the emerging literature on the association between maternal CMD and impaired infant growth. Whereas several studies from South Asia have found infants of women with postnatal CMD to be more likely to be underweight or stunted (Patel *et al.* 2003; Anoop *et al.* 2004; Rahman *et al.* 2004), the published studies from sub-Saharan Africa show a mixed picture (Harpham *et al.* 2005; Tomlinson *et al.* 2005). In South Africa, neither postnatal nor current depression was associated with infant growth at two and 18 months after adjusting for birth weight, although the effect of antenatal CMD was not assessed and the study was under-powered (Tomlinson *et al.* 2005). In a multi-country study assessing maternal CMD and child growth contemporaneously at six to eighteen months postpartum, no cross-sectional association between maternal CMD and child under-nutrition was found in Ethiopia (Harpham *et al.* 2005). However, clinic-based studies from Uganda and Nigeria did find significant associations. In Malawi, postnatal CMD was associated with significantly lower mean height- but not weight-for-age at a median infant age of 9.9 months, in an adjusted model (Stewart *et al.* 2008). In Nigeria, low infant weight and length (below the fifth centile) were significantly associated with postnatal CMD at three and 6 months, but not at 9 months. No adjustment was made for potential confounders.

Table 4 Crude and adjusted relative risks (RR) of perinatal outcomes for psychosocial exposures during pregnancy (with robust standard errors)

Relative risk (RR) (95% CIs)	Low birth weight* (38 of 521)	Stillbirth† (40 of 1046)	Neonatal death‡ (35 of 1006)	Prolonged labour (210 of 1038)	Delayed breast-feeding > 8 h§ (68 of 969)
Crude					
SRQ score					
Zero	Ref.	Ref.	Ref.	Ref.	Ref.
1–5	1.2 (0.6–2.5)	0.6 (0.3–1.2)	0.9 (0.4–1.8)	1.4 (1.0–1.9)	1.3 (0.7–2.4)
≥6	1.6 (0.6–4.3)	1.0 (0.4–2.6)	0.7 (0.2–2.3)	1.6 (1.1–2.5)	2.6 (1.3–5.2)
Adj.					
SRQ score					
Zero	Ref.	Ref.	Ref.	Ref.	Ref.
1–5	1.2 (0.6–2.6)	0.6 (0.3–1.3)	1.0 (0.5–2.1)	1.4 (1.0–1.9)	1.4 (0.8–2.4)
≥6	2.3 (0.9–6.2)	1.7 (0.6–5.5)	0.8 (0.2–3.0)	1.6 (1.0–2.6)	2.8 (1.3–6.1)
Crude					
Life events					
0	Ref.	Ref.	Ref.	Ref.	Ref.
1	0.9 (0.4–2.0)	1.4 (0.7–2.7)	1.3 (0.6–2.8)	0.8 (0.6–1.1)	0.9 (0.5–1.6)
≥2	0.7 (0.3–2.1)	0.5 (0.1–1.6)	1.1 (0.5–2.8)	1.4 (1.0–1.9)	1.4 (0.8–2.4)
Adj.					
Life events					
0	Ref.	Ref.	Ref.	Ref.	Ref.
1	1.0 (0.5–2.2)	1.5 (0.8–3.0)	1.6 (0.7–3.2)	0.8 (0.6–1.2)	0.8 (0.4–1.5)
≥2	1.0 (0.4–2.8)	0.7 (0.2–2.8)	1.6 (0.6–4.1)	1.3 (0.9–1.8)	1.1 (0.6–2.1)
Crude					
Worry	1.1 (0.5–2.3)	1.4 (0.6–3.4)	1.4 (0.6–3.3)	1.6 (1.1–2.3)	0.9 (0.5–1.6)
Adj.	1.0 (0.4–2.3)	1.4 (0.6–3.3)	1.3 (0.5–3.1)	1.5 (1.0–2.1)	1.3 (0.5–3.1)

The analyses for all five perinatal outcomes were adjusted for the shared confounders (as defined in Tables 1 and 2) plus other outcome-specific confounders as follows:

*No antenatal care and physical assault (adjusted model $n = 515$).

†Polygamous marriage, unwanted pregnancy, physical assault and past history of stillbirth (adjusted model $n = 1025$).

‡Polygamous marriage, unwanted pregnancy, physical assault, past history of neonatal death, no antenatal tetanus toxoid, no antenatal care and poor sanitation (adjusted model $n = 989$).

§Polygamous marriage, unwanted pregnancy, no antenatal care and ethnicity (adjusted model $n = 953$).

It is too early to determine whether there is aetiological heterogeneity across these settings, with their different cultures, health systems, and maternal and child health profiles. In Ethiopia the high prevalence of maternal undernutrition and physical ill-health, socio-economic disadvantage and lack of education may overwhelm any additional effect of CMD on birth weight. In addition, our study was unable to distinguish the aetiologically distinct outcomes of LBW secondary to intra-uterine growth retardation (IUGR) and that resulting from normally growing babies born preterm. In both studies from South Asia, premature deliveries were excluded and the observed association was thus between antenatal CMD and IUGR (Patel *et al.* 2003; Rahman *et al.* 2004). A further factor limiting our ability to detect an association was the low prevalence of low birth weight babies in our sample (7.1%) compared to that observed in the Pakistan study (25.0%), although not the India study (10.6%) (Patel & Prince 2006; Rahman *et al.* 2007). Given that the risk ratio estimates for the association between the highest category of CMD symptoms and the outcome of low birth weight (<2500 g) had confidence intervals approaching one, it is possible that we were underpowered to detect a true association if one had existed.

Grouping together foetal deaths occurring pre- and intra-partum means our category of stillbirth is likely to be aetiologically heterogeneous (Say *et al.* 2006). Misclassification of stillbirth and early neonatal death is also possible in this setting where few deliveries are attended by health professionals. This may have limited our ability to detect associations between antenatal CMD and either stillbirth or neonatal death.

Our finding of an independent, specific and prospective association between worry about delivery and prolonged labour is consistent with findings from high-income settings (Lederman *et al.* 1985; Bonari *et al.* 2004). What may seem an entirely understandable fear of giving birth in a setting where maternal mortality and other adverse birth outcomes are frequent may thus itself be associated with worse perinatal outcome.

Although some researchers have explored the relationship between maternal CMD and early cessation of breastfeeding (Patel *et al.* 2003), we are unaware of any previous studies which have looked at the effect of maternal CMD on the timing of initiation of breastfeeding. Delayed initiation of breastfeeding has been associated with a number of adverse outcomes: increased early neonatal mortality (Edmond *et al.* 2006), more diarrhoeal episodes (Clemens *et al.* 1999), failure to establish breastfeeding and impaired mother-infant bonding (WHO Division of Child Health and Development 1998). Identified determinants of delayed initiation include ethnic group and cultural ideas regarding colostrum (Gunnlaugsson *et al.* 1992). In our study very few women (1.4%) delayed breastfeeding more than 24 h, but even a few hours delay may be detrimental to the neonate. The detrimental impact of maternal CMD on a woman's ability to optimally care for her infant has been explored in relation to older infants (Patel *et al.* 2003; Rahman *et al.* 2004) and may similarly affect her capacity to provide care and nourishment in the early neonatal period.

The validity of SRQ-20 when tested against a local clinician's diagnostic criterion was fair to good in this setting and could have led to some misclassification of exposure. This is likely to have been non-differential with respect to our outcome measures, particularly birth weight, and to have led to an underestimation of any genuine associations. However, the strong cross-sectional associations observed between SRQ caseness and a variety of its expected co-determinants is reassuring regarding the construct validity of the measure (Hanlon *et al.* 2007). The SRQ-20 includes several somatic items which could reflect physical symptoms of late pregnancy or physical ill-health rather than emotional distress. However, although SRQ score was strongly associated with all self-report measures of ill-health in pregnancy, the independent associations of SRQ score with delayed breastfeeding and prolonged labour remained after adjustment for maternal ill-health.

The proportion of babies with LBW in our sample (7.1%) was half the estimated national average for Ethiopia (Wardlaw *et al.* 2004; Central Statistical Authority [Ethiopia] and ORC Macro 2006). Whereas these national estimates were largely derived from health facility data, one of the few other community-based studies from Ethiopia gave a prevalence estimate for LBW closer to our finding (9.5%) (Asefa & Tessema 1997). The selective under-recording in our study of birth weights in primiparous women and babies which died in the early neonatal period is likely to have led to an underestimation of underweight babies. Also it is preferable for birth weight to be measured within 24 h of birth due to unpredictable rates of postnatal weight loss. Delays in the measurement of birth weight could lead to over-estimation of LBW, although in our sample the mean birth weight did not differ significantly between babies weighed within 24 h and those up to 48 h after birth. The effect of these possible sources of measurement error on the observed associations with the determinants of birth weight is difficult to predict and bias cannot be excluded. However, the pattern of exposures associated with lower birth weight in the final adjusted model largely accords with that expected from the literature.

In summary, our population-based study from rural Ethiopia found no association between antenatal CMD and lower birth weight, in contrast to studies conducted in South Asia. However, we did find evidence of important public health consequences of poor maternal mental health in low-income countries in terms of prolonged labour and delayed initiation of breastfeeding.

We are continuing intensively to follow-up 1006 singleton babies born to the 1065 mothers in the P-MaMiE cohort up to 12 months post-partum, and will soon be in a position to report on longer-term associations between antenatal and postnatal CMD and infant growth, development and mortality.

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